Dietary Digestible Lysine Requirements of Male and Female Broilers from Forty-Nine to Sixty-Three Days of Age[1]

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ABSTRACT Experiments were conducted to evaluate digestible (dig) Lys requirements of male and female broiler chickens from 49 to 63 d of age. A dose-response diet consisting of corn, soybean meal, and corn gluten meal was formulated to be adequate in dig amino acid concentrations with the exception of Lys. L-Lysine·HCl was added to the dose-response diet to create 7 experimental diets. Concentrations of dig Lys of experimental diets ranged from 0.50 to 1.04% in increments of 0.09%. Variables measured consisted of standardized dietary Lys digestibility, feed intake, dig Lys intake, BW gain, feed conversion, mortality, abdominal fat weight and percentage, carcass weight and yield, and total breast meat weight and yield. In experiment 1, dig Lys of the dose-response diet was determined as 0.51% with cecectomized roosters. In experiment 2, dig Lys requirements of male broilers for BW gain, feed conversion, breast meat weight, and breast meat yield were 0.86, 0.88, 0.90, and 0.90%, respectively, based on 95% of the responses. From 49 to 63 d of age, male broilers optimized growth and meat yield measurements with approximately 3.0 g of dig Lys intake. In experiment 3, dig Lys requirements of female broilers were estimated as 0.79 and 0.83%, respectively, for BW gain and feed conversion. Digestible Lys intake necessary to optimize growth performance was 2.8 g/bird during 49 to 63 d of age. These results indicate that dig Lys requirements for male broilers were 0.87 and 0.90% of the diet, respectively, for growth performance and breast meat yield. Conversely, the dig dietary Lys requirement for females was 0.81% based only on growth performance.

Key words: amino acid, breast meat, broiler, lysine

2008 Poultry Science 87:1385–1391
doi:10.3382/ps.2007-00529

INTRODUCTION

The demand for breast meat and value-added products in the United States has resulted in increased market weights of broiler chickens. This has prompted primary breeding companies to develop genetic strains that yield greater amounts of pectoralis major and minor breast muscles when broilers are grown to heavy weights. The need for dietary Lys is greater for breast meat yield than for growth rate (Acar et al., 1991; Bilgili et al., 1992; Kidd et al., 1998; Corzo et al., 2006; Sterling et al., 2006). The Lys composition of the pectoralis major and minor breast muscles is relatively greater compared with other amino acids (Munks et al., 1945). In addition, the modern broiler grows faster per unit of feed intake and accretes more breast meat than commercial broilers of the previous decade, which should translate to a greater dietary Lys requirement than determined with past research.

Corzo et al. (2002, 2003) determined that Ross × Ross 308 male broilers from 42 to 56 d of age required approximately 0.85% dietary Lys (total basis), which was in close agreement with the NRC (1994) Lys recommendation from 6 to 8 wk of age. Conversely, Corzo et al. (2006) estimated the dietary Lys requirement as 0.93% for optimum breast meat yield using Hubbard × Ultra Yield male broilers from 42 to 56 d of age. Dietary Lys requirement could not be predicted for BW gain or feed conversion. Furthermore, diets fed ranged from 0.68 to 1.10% in total Lys and so the requirement could not be estimated for females based on growth and meat yield parameters, indicating that the need for Lys with females is less than males from 42 to 56 d of age. The dietary Lys requirement for heavy broilers appears to be inconclusive, and factors such as genetic strain, ambient temperature, and dietary CP have contributed to variable results.

Target weights of some "big bird" complexes are approaching 4.0 kg for straight-run broilers during winter production. However, information is not available on the dietary Lys requirement of male and female broilers from

Received December 31, 2007.
Accepted March 31, 2008.

[1]Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA or Mississippi State University.

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49 to 63 d of age (≤4.0 kg). This study examined the dietary digestible (**dig**) Lys requirement of male and female broilers from 49 to 63 d of age based on growth performance and meat yield.

MATERIALS AND METHODS

Dietary Treatments

Dietary treatments consisted of 7 concentrations of dig Lys and a positive control. Dietary dig Lys concentrations ranged from 0.50 to 1.04% in increments of 0.09% and the positive control diet was formulated to 0.86% dig Lys based on previous research (Corzo et al., 2006). L-Lysine HCl and inert filler were added to random aliquots of a common dose-response diet to create the experimental diets. The dose-response diet was formulated to meet or exceed the nutrient requirements recommended by NRC (1994) with the exception of Lys (Table 1). Corn, soybean meal, and corn gluten meal were analyzed for total amino acids (AOAC, 2000; method 982.30 E [a,b]) and CP (AOAC, 2000) composition before diet formulation. Digestible amino acid values were determined from dig coefficients (Ajinomoto Heartland, 2004) and analyzed total amino acid content of the ingredients. Digestible amino acid concentrations were determined in the ingredient matrix based on least-cost formulation. Minimum dig TSAA, Thr, Val, Ile, Arg, and Trp concentrations were formulated based on dig ratios reported by Lemme et al. (2004). A dig Lys of 0.86% was set as the reference for the ratios and these essential amino acid concentrations were formulated to 110% of their requirement to ensure that they were not limiting.

Experiment 1

Standardized amino acid digestibility of the dose-response diet was determined using cecectomized Single Comb White Leghorn roosters at the University of Illinois (Parsons, 1985). A 30-g sample of the dose-response diet was tube-fed to 5 cecectomized roosters. Roosters were individually housed and fasted 24 h before experimentation (Parsons, 1985). All excreta voided over the following 48-h period were collected and freeze-dried. Amino acid concentrations in the diet and excreta were determined at the University of Missouri–Columbia Experiment Station Chemical Laboratory (AOAC, 2000; method 982.30 E [a,b]). Performic acid oxidation (AOAC, 2000; method 982.30 E [b]) was conducted before acid hydrolysis for the determination of Met and Cys, whereas all other amino acids were determined following acid hydrolysis.

Experiments 2 and 3

Bird Husbandry. Two thousand Ross × Ross 708 broiler chicks were obtained from a commercial hatchery and raised in a curtain-sided house and fed common diets until 48 d of age. Chicks were vaccinated at the hatchery for Marek's disease, Newcastle disease, and infectious bronchitis. At 12 d of age, birds received a Gumboro vaccination via water administration. Two experiments (experiment 2 = males and experiment 3 = females) were conducted simultaneously from 49 to 63 d of age. At 49 d of age, 15 birds were randomly distributed into each of 48 floor pens (0.09 m^2/bird) in a solid-sided facility. Each pen was equipped with a hanging feeder, a drinker line (7 nipples), and used litter. Feed and water were available for ad libitum consumption and experimental diets were provided as whole pellets. Temperature was set at 16.5°C from 49 to 52 d of age, 15.6°C from 53 to 58 d of age, and 14.0°C from 59 to 63 d of age. These temperature set points were modified based on previous research conducted at our laboratory (Dozier et al., 2007). Ventilation was provided at approximately 3.4 m^3/h of air flow, and a chilled-water air conditioning system was used to control temperature. Lighting was provided continuously at an intensity of 3 lx.

Measurements. Both feed intake and birds were weighed on d 63 so that BW gain, feed intake, dig Lys intake, and feed conversion could be determined for the d 49 to 63 experimental period. Mortality was recorded daily. The following day, 5 birds per pen were randomly selected for processing. Feed was removed 12 h before processing. The birds selected for processing were placed in coops and transported to the Mississippi State University processing plant. Birds were electrically stunned, bled, scalded, mechanically picked, and mechanically eviscerated. Whole carcass (without abdominal fat pad) and abdominal fat pad were weighed. Carcasses were split into front and back halves and placed on ice for 18 h after which the front halves were deboned to obtain weights of pectoralis major and minor muscles. Carcass yield, abdominal fat pad, and total breast meat yields (sum of pectoralis major and minor muscles) were determined from live weights of the broilers selected for processing at 64 d of age.

Statistics. In experiments 2 and 3, gradient treatment structure was conducted as a randomized complete block design. Dietary treatments were represented with 6 replicate pens with pen serving as the experimental unit. Five analyses were conducted: 1) PROC REG (SAS Institute, 2004) using linear trend to explain potential dig Lys effects; 2) PROC REG (SAS Institute, 2004) using quadratic trend to explain potential dig Lys effects; 3) an orthogonal contrast was conducted to compare the control diet vs. 0.86% dig Lys from the dose-response diet; 4) a straight-broken line model was evaluated using PROC NLIN (SAS Institute, 2004) based on Robbins et al. (2006); 5) quadratic-broken models were conducted using PROC NLIN (SAS Institute, 2004) and PROC NLMIXED (SAS Institute, 2004) based on Robbins et al. (2006). Quadratic equations and broken line models were used to estimate nutrient requirements. With the quadratic equation, the dietary dig Lys requirement was estimated at 95% of the response by regression analysis when a quadratic trend was observed ($P \leq 0.05$). Dietary dig Lys requirement was also estimated using broken line methodology when a significant ($P \leq 0.05$) trend occurred.

Table 1. Ingredient and calculated composition of diets provided during a 63-d production period (%, as-fed basis)

Item	Common diets			Experimental diets (49 to 63 d)	
	Starter (0 to 17 d)	Grower (18 to 32 d)	Finisher (33 to 48 d)	Control	Dose-response
Ingredient, %					
Ground corn	56.14	61.57	64.95	72.82	76.42
Soybean meal (48% CP)	32.34	27.46	25.66	20.17	8.91
Poultry by-product meal	5.00	5.00	3.00	—	—
Corn gluten meal (66% CP)	—	—	—	—	8.00
Poultry oil	3.17	3.03	3.57	3.47	1.63
Dicalcium phosphate	1.27	1.04	1.01	1.40	1.43
Calcium carbonate	0.99	0.89	0.86	0.97	1.00
Sodium chloride	0.48	0.48	0.47	0.50	0.11
Sodium bicarbonate	—	—	—	—	0.56
Potassium chloride	—	—	—	—	0.40
DL-Met	0.22	0.17	0.15	0.16	0.11
L-Lys·HCl	0.03	—	—	0.11	—
L-Thr	—	—	0.02	0.09	0.12
L-Trp	—	—	—	—	0.06
L-Ile	—	—	—	—	0.01
L-Arg	—	—	—	—	0.12
Choline chloride	—	—	—	—	0.06
Mineral and vitamin premix[1]	0.25	0.25	0.25	0.25	0.25
Cocciodostat[2]	0.05	0.05	—	—	—
Copper sulfate	0.05	0.05	0.05	0.05	0.05
Zinc sulfate	0.01	0.01	0.01	0.01	0.01
Inert filler[3]	—	—	—	—	0.75
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
AME, kcal/kg	3,085	3,140	3,200	3,220	3,220
CP, %	22.5	20.5	18.5	17.3	17.6
Digestible (dig) TSAA, %	0.88	0.79	0.69	0.67	0.67
dig Lys, %	1.21	1.06	0.91	0.86	0.50
dig Thr, %	0.73	0.67	0.60	0.62	0.63
dig Ile, %	0.90	0.82	0.72	0.63	0.61
dig Val, %	1.00	0.91	0.78	0.71	0.69
dig Trp, %	0.25	0.22	0.20	0.17	0.18
dig Arg, %	1.41	1.27	1.12	1.00	1.00
Calcium, %	0.94	0.84	0.74	0.74	0.74
Nonphytate phosphorus, %	0.47	0.42	0.37	0.37	0.37
Sodium, %	0.23	0.23	0.22	0.23	0.22

[1]Vitamin and mineral premix include per kilogram of diet: vitamin A (vitamin A acetate), 7,716 IU; cholecalciferol, 2,205 IU; vitamin E (source unspecified), 9.9 IU; menadione, 0.9 mg; vitamin B_{12}, 0.01 mg; folic acid, 0.6 μg: choline, 379 mg; D-pantothenic acid, 8.8 mg; riboflavin, 5.0 mg; niacin, 33 mg; thiamin, 1.0 mg; D-biotin, 0.06 mg; pyridoxine, 0.9 mg; ethoyquin, 28 mg; manganese, 55 mg; zinc, 50 mg; iron, 28 mg; copper, 4 mg; iodine, 0.5 mg; selenium, 0.1 mg.

[2]Sacox 60 provided 60 g/907 kg of Salinomycin (Intervet Inc., Millsboro, DE).

[3]Builder's sand was used as the inert filler.

RESULTS

Experiment 1

This dose-response diet was formulated to be deficient in dig Lys and adequate in all other amino acids, as described previously. Dose-response diet was analyzed to contain 0.59% total Lys (Table 2). Standardized digestible Lys was determined to be 0.51% using the cecectomized rooster assay. Both total and dig amino acid levels were in good agreement with their calculated values.

Experiment 2

The dose-response diet deficient in dig Lys caused reduced growth rate and meat yield with both male and female broilers compared with broilers fed diets adequate in Lys (Table 3 and Table 4). Progressive additions of Lys to the dose-response diet improved ($P \leq 0.01$) BW, BW gain, feed intake, Lys intake, feed conversion, carcass weight, breast meat weight, and breast meat yield of male broilers (Table 3). Male broilers fed the positive control diet had similar growth rate and meat yield when compared with the 0.86% dig Lys diet (dose-response). Quadratic regression equations estimated dig Lys requirement as 0.86, 0.86, 0.88, 0.87, 0.90, and 0.90%, respectively, for BW gain, feed intake, feed conversion, carcass weight, total breast meat weight, and total breast meat yield (Table 5). The quadratic-broken line model estimated higher requirements than the quadratic regression equations. Digestible Lys requirements were 0.91, 0.92, 0.89, 0.92, 0.97, and 0.97% for BW gain, feed intake, feed conversion, carcass weight, breast meat weight, and breast meat yield based upon the quadratic broken-line method (Table 6). The straight-broken line model predicted the lowest requirement for the 3 models. The dig Lys requirement

Table 2. Amino acid digestibility of the dose-response diet provided to cecectomized roosters

Amino acid	Total dietary, %	Standardized digestible,[1] %
Asp	1.23	1.12
Thr	0.67	0.62
Ser	0.69	0.64
Glu	2.92	2.80
Pro	1.13	1.10
Ala	1.07	1.00
Cys	0.29	0.27
Val	0.73	0.68
Met	0.38	0.36
Ile	0.64	0.60
Leu	1.87	1.80
Tyr	0.61	0.57
Phe	0.85	0.83
Lys	0.59	0.51
His	0.39	0.35
Arg	1.00	0.97
Trp	0.21	0.19

[1]Amino acid digestibility values were determined using the total fecal collection precision-fed cecectomized rooster assay (Han and Parsons, 1990).

was estimated as 0.79, 0.80, 0.78, 0.77, 0.79, and 0.80%, respectively, for BW gain, feed intake, feed conversion, carcass weight, total breast meat weight, and total breast meat yield.

Experiment 3

Growth rate, Lys intake, and feed conversion of females were significantly improved ($P \leq 0.04$) by gradient additions of Lys to the dose-response diet (Table 4). Carcass and breast weight, and yield of female broilers were not influenced by progressive additions of Lys. Female broilers fed the dose-response diet (0.86% dig Lys) had good performance and meat yield compared with the positive control fed birds. The dig Lys requirement of female broilers for growth rate and feed conversion were estimated as 0.79 and 0.83%, respectively, based on regression equations (Table 5). With the broken line models, requirement for feed conversion was estimated as 0.77 and 0.62%, respectively, for quadratic- and straight-broken line models (Table 6).

DISCUSSION

When designing experiments to evaluate dig amino acid requirements, it is important to determine the dig value of the test amino acid in the dose-response diet. Digestible Lys was determined as 0.50% and was shown to be clearly deficient to both male and female broilers. With both male and female broilers, dig Lys requirement varied with the model used to estimate the requirement. The straight-line analysis will underestimate the requirement with curvilinear data (Robbins et al., 2006). The quadratic-broken line model may have overestimated the requirement for males when compared with regression equations, but the converse occurred with females.

The dig Lys requirement was estimated as 0.88 and 0.81%, respectively, for male and female broilers in the research reported herein. Males had numerically (gender differences were not statistically evaluated) greater 49- to 63-d growth rate (1.12 vs. 0.93 kg) and breast meat weight (1.10 vs. 0.90 kg) than females, translating to a greater dietary Lys requirement. Previous research has reported that dietary Lys requirement is greater for male than female broilers (Han and Baker, 1994; Corzo et al., 2006).

In contrast to our findings in the present research, total dietary Lys requirement has been estimated as 0.85% using Ross × Ross 308 male broilers from 42 to 56 d of age (Corzo et al., 2002, 2003), which is in agreement with NRC (1994) dietary Lys requirement for 6- to 8-wk-old broilers. In contrast, Corzo et al. (2006) reported a total dietary Lys requirement of 0.93% from 42 to 56 d of age using male Ross × Hubbard UY broilers based on breast meat yield, but a requirement was not estimated based on growth and feed conversion. These researchers were not able to estimate a dietary Lys requirement for females.

Table 3. Dietary digestible Lys effects of male broilers on growth performance and meat yield responses from 49 to 63 d of age (experiment 1)[1]

	Digestible dietary Lys, %									*P*-value		
Variable	0.50	0.59	0.68	0.77	0.86	0.95	1.04	0.86% (control)	SEM	L[2]	Q[3]	Control[4] vs. 0.86%
BW, kg	4.517	4.657	4.757	4.844	4.913	4.832	4.855	4.957	0.053	0.013	0.001	0.56
BW gain, kg	0.884	1.000	1.085	1.195	1.244	1.191	1.222	1.304	0.049	0.006	0.001	0.39
Feed intake, kg	3.091	3.122	3.264	3.350	3.399	3.340	3.340	3.343	0.058	0.016	0.009	0.42
Lys intake, g	1.549	1.842	2.212	2.576	2.931	3.169	3.474	2.402	0.180	0.001	0.001	0.045
Feed conversion, kg:kg	3.584	3.132	3.034	2.809	2.766	2.710	2.737	2.567	0.113	0.007	0.001	0.22
Mortality, %	1.11	2.22	1.11	2.22	1.11	2.22	1.11	0.00	1.32	0.99	0.79	0.55
Carcass weight, kg	3.315	3.420	3.483	3.655	3.640	3.618	3.648	3.642	0.073	0.008	0.004	0.99
Carcass yield, %	74.5	74.9	75.5	75.3	75.3	74.9	75.1	75.3	0.4	0.34	0.095	0.94
Abdominal fat, kg	0.098	0.091	0.099	0.100	0.105	0.111	0.103	0.100	0.006	0.050	0.18	0.56
Abdominal fat yield, %	2.19	1.99	2.14	2.07	2.17	2.31	2.11	2.08	0.11	0.49	0.77	0.57
Breast meat, kg	0.990	1.044	1.075	1.144	1.136	1.166	1.147	1.151	0.025	0.004	0.001	0.77
Breast meat yield, %	22.2	22.9	23.3	23.5	23.5	24.2	23.6	23.8	0.2	0.010	0.009	0.36

[1]Values represent least square means of 6 replicate pens with 15 birds per pen at 49 d of age.

[2]Linear effect.

[3]Quadratic effect.

[4]Orthogonal contrast.

Table 4. Dietary dig Lys effects of female broilers on growth performance and meat yield responses from 49 to 63 d of age (experiment 2)[1]

Variable	Digestible dietary Lys, % 0.50	0.59	0.68	0.77	0.86	0.95	1.04	0.86% (control)	SEM	*P*-value L[2]	Q[3]	Control[4] vs. 0.86%
BW, kg	3.812	3.940	3.930	3.952	3.944	3.928	3.938	3.973	0.040	0.17	0.08	0.63
BW gain, kg	0.828	0.929	0.956	0.974	0.955	0.942	0.945	0.964	0.043	0.15	0.020	0.88
Feed intake, kg	3.019	3.060	3.150	3.020	3.072	3.056	2.998	2.959	0.054	0.61	0.36	0.15
Lys intake, g	1.510	1.806	2.143	2.326	2.642	2.903	3.117	2.545	0.041	0.001	0.001	0.11
Feed conversion, kg:kg	3.718	3.356	3.344	3.112	3.256	3.284	3.188	3.075	0.138	0.07	0.040	0.07
Mortality, %	2.22	2.22	2.22	0.00	1.11	2.22	0.00	0.00	0.14	0.47	0.73	0.47
Carcass weight, kg	2.773	2.832	2.777	2.807	2.866	2.806	2.770	2.785	0.047	0.90	0.47	0.23
Carcass yield, %	73.5	71.0	71.5	72.2	73.7	71.4	73.3	71.9	1.28	0.74	0.70	0.35
Abdominal fat, kg	0.115	0.119	0.116	0.119	0.124	0.119	0.115	0.114	0.006	0.74	0.28	0.24
Abdominal fat yield, %	3.042	2.987	3.003	3.060	3.193	3.020	3.033	2.933	0.157	0.57	0.71	0.25
Breast meat, kg	0.849	0.946	0.899	0.918	0.905	0.912	0.899	0.896	0.022	0.62	0.45	0.77
Breast meat yield, %	22.5	23.7	23.2	23.6	23.2	23.2	23.8	23.1	0.4	0.25	0.47	0.82

[1]Values represent least square means of 6 replicate pens with 15 birds per pen at 49 d of age.

[2]Linear effect.

[3]Quadratic effect.

[4]Orthogonal contrast.

The experimental diets ranged in total Lys from 0.68 to 1.10%. Significant progress has been made with genetic strains over the last 4 to 5 yr in regard to feed consumed per unit of BW gain. The genetic strain used by Corzo et al. (2002, 2003) may have consumed more feed per unit of BW gain than the modern broiler used in the present experiment, and this difference of feed consumed per unit of BW gain would translate to differences in dietary Lys needs. In addition, the improvements in lean tissue accretion that primary breeding companies have made with the modern broiler may account for these differences with determined dig Lys requirements.

Providing ambient temperature at set points below the upper limit of the thermoneutral zone provides good broiler performance (May and Lott, 2001). Dozier et al. (2007) reported that broilers subjected to temperatures declining from 21 to 13°C from 36 to 60 d of age had superior performance over broilers reared with a temperature set point of 21°C. In the current research, temperature set points used by Dozier et al. (2007) were employed and as a result, rapid growth was displayed with maximum BW of males being 4.91 kg and females having a BW of 3.95 kg. Corzo et al. (2002, 2003) reported an average temperature of 18 and 28°C, respectively, and Corzo et al. (2006) did not report an average temperature. The difference in growth rates due to temperature among the present and previous research may have led to a more pronounced response to dietary Lys in the research reported herein. In support of the present findings, Dozier et al. (2000a) reported a greater dietary Thr requirement for male broilers from 42 to 56 d of age than Dozier et al. (2000b). Strain source, management, facilities, and dose-response diets were similar with the difference being that Dozier et al. (2000a) was conducted with temperatures emulating a grow-out during winter months, whereas Dozier et al. (2000b) had ambient temperature and humidity similar to environmental conditions in summer production.

Dietary CP has been reported to influence the Lys requirement of broiler chicks (Morris et al., 1987; Hurwitz et al., 1998). Hence, CP can be a factor that limits the dietary Lys requirement in dose-response research. Corzo et al. (2002, 2003) used an 18.0% CP dose-response diet, and the dose-response diet in the current study was formulated to 17.6% CP. Conversely, Corzo et al. (2006) formulated a corn-soybean meal dose-response diet to

Table 5. Dietary digestible Lys requirement of male and female broilers from 49 to 63 d of age based on regression analysis[1]

Response criterion	Equation[2]	R^2	CV, %	Requirement[3]
Males – experiment 2				
BW gain, kg	–0.373 + 3.409 × (Lys) – 1.851 × (Lys × Lys)	0.971	2.49	0.86
Feed intake, kg	1.908 + 3.169 × (Lys) – 1.721 × (Lys × Lys)	0.904	1.39	0.86
Feed conversion, kg:kg	6.526 – 8.162 × (Lys) + 4.359 × (Lys × Lys)	0.975	2.08	0.88
Carcass weight, kg	2.099 + 3.273 × (Lys) – 1.725 × (Lys × Lys)	0.937	1.17	0.87
Breast meat weight, kg	0.433 + 1.489 × (Lys) – 0.768 × (Lys × Lys)	0.965	1.37	0.90
Breast meat yield, %	16.892 + 14.586 × (Lys) – 7.689 × (Lys × Lys)	0.905	0.99	0.90
Females – experiment 3				
BW gain, kg	0.168 + 1.928 × (Lys) – 1.152 × (Lys × Lys)	0.856	2.48	0.79
Feed conversion, kg:kg	5.756 – 5.881 × (Lys) + 3.349 × (Lys × Lys)	0.799	3.21	0.83

[1]R^2 = multiple coefficient of determination; CV = coefficient of variation: SD ÷ mean × 100.

[2]Prediction equation based on formulated digestible dietary Lys for optimum response.

[3]Digestible dietary Lys requirement estimates 95% of the asymptote.

Table 6. Dietary digestible Lys requirement based on broken line model analyses

Response criterion	Estimated requirement[1,2]	95% CI[3]	*P*-value	R^2
	Quadratic broken line analysis			
Males – experiment 2				
BW gain, kg	0.91 ± 0.084	0.74–1.08	0.0001	0.539
Feed intake, kg	0.92 ± 0.153	0.61–1.23	0.0001	0.372
Feed conversion, kg:kg	0.89 ± 0.109	0.69–1.10	0.0001	0.545
Carcass weight, kg	0.92 ± 0.135	0.59–1.25	0.0003	0.339
Breast meat weight, kg	0.97 ± 0.114	0.69–1.26	0.0001	0.495
Breast meat yield, %	0.97 ± 0.098	0.68–1.27	0.0001	0.476
Females – experiment 3				
Feed conversion, kg:kg	0.77 ± 0.100	0.46–1.08	0.014	0.197
	Linear broken line analysis			
Males – experiment 2				
BW gain, kg	0.79 ± 0.046	0.70–0.89	0.0001	—
Feed intake, kg	0.80 ± 0.065	0.67–0.93	0.0001	—
Feed conversion, kg:kg	0.78 ± 0.045	0.69–0.88	0.0001	—
Carcass weight, kg	0.77 ± 0.060	0.65–0.90	—	
Breast meat weight, kg	0.79 ± 0.050	0.69–0.90	0.0001	—
Breast meat yield, %	0.80 ± 0.056	0.68–0.90	0.0001	—
Females – experiment 3				
Feed conversion, kg:kg	0.62 ± 0.051	0.52–0.72	0.014	—

[1]The quadratic broken-line model is $y = L + U \times (R - x) \times (R - x)$ where L is the ordinate, R is the abscissa of the breakpoint, and the value R - is zero at values of x > R. Values are reported as ± SEM.

[2]The linear broken-line model is $y = L + U \times (R - x)$, where L is the ordinate, R is the abscissa of the breakpoint, and the value R – is zero at values of x > R. Values are reported as ± SEM.

[3]95% confidence interval of the digestible dietary Lys requirement.

contain 15.0% CP. The difference in response to dietary Lys between Corzo et al. (2002, 2003) and the present research was clearly not related to dietary CP. Strain source, bird age, temperature regimen, and ingredient and nutrient composition of the dose-response diets were different with Corzo et al. (2002, 2003) than the present research so an explanation of the inconsistent Lys requirement estimates is not apparent.

In the current research, dig Lys requirement using the quadratic equations ranged from 0.86 to 0.90% and 0.79 to 0.83% for male and female broilers, respectively. An average dig Lys requirement is estimated as 0.88% (total 1.02%) and 0.81% (total 0.93%) for male and female broilers when both growth and meat yield variables are considered collectively. These results indicated that the NRC (1994) Lys requirement of 0.85% (total basis) is not adequate from 6 to 8 wk of age for Ross × Ross 708 broilers.

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